SILICON N-P-N "overlay" TRANSISTOR

2N5109

File No. 281

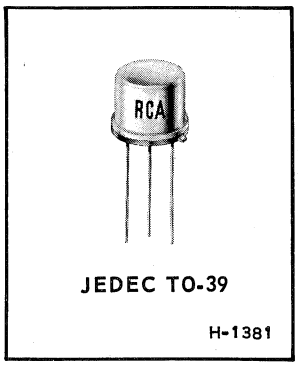
RCA-2N5109* is an epitaxial silicon n-p-n planar transistor of the "overlay" emitter electrode construction. It is especially designed to provide large dynamic range, low distortion, and low noise as a wide band amplifier into the VHF range.

The features of high and constant f_T, gain-bandwidth product, over a wide range of collector current make the 2N5109 ideally suited for such applications as CATV and MATV line amplifiers and low-noise linear amplifiers.

In the overlay structure, there are a number of individual emitter sites which are all connected in parallel and used in conjunction with a common collector region. When compared with other structures, this arrangement provides a substantial increase in emitter periphery for higher current or power, and a corresponding decrease in emitter and collector areas for lower input and output capacitances. The overlay structure thus offers greater power output, gain, efficiency, frequency capability, and linearity.

*Formerly RCA-Dev. No.TA2800.

Nearly-Constant f_T vs. I_C Device for Operation in VHF-UHF Circuits



JEDEC TO-39

H-1381

- High Gain-Bandwidth Product, f_T
- For CATV & MATV Amplifiers
- For Linear Amplifiers With Large Dynamic Range
- Low Distortion
- Low Noise

RATINGS

Maximum Ratings, *Absolute-Maximum Values:*

COLLECTOR-TO-BASE VOLTAGE	V_{CBO}	40	V
COLLECTOR-TO-EMITTER VOLTAGE:			
With external base-to-emitter resistance, R_{BE} = 10 Ω	V_{CER}	40	V
EMITTER-TO-BASE VOLTAGE	V_{EBO}	3	V
COLLECTOR CURRENT	I_C	0.4	A
TRANSISTOR DISSIPATION	P_T		
At case temperatures up to 25° C		3.5	W
At case temperatures above 25° C		See *Fig.10*	
TEMPERATURE RANGE:			
Storage & Operating (Junction)		−65 to 200	°C
LEAD TEMPERATURE (During soldering):			
At distances ≥ 1/32 in. from insulating wafer for 10 s max.		230	°C

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TYPICAL GAIN-BANDWIDTH PRODUCT vs. COLLECTOR CURRENT

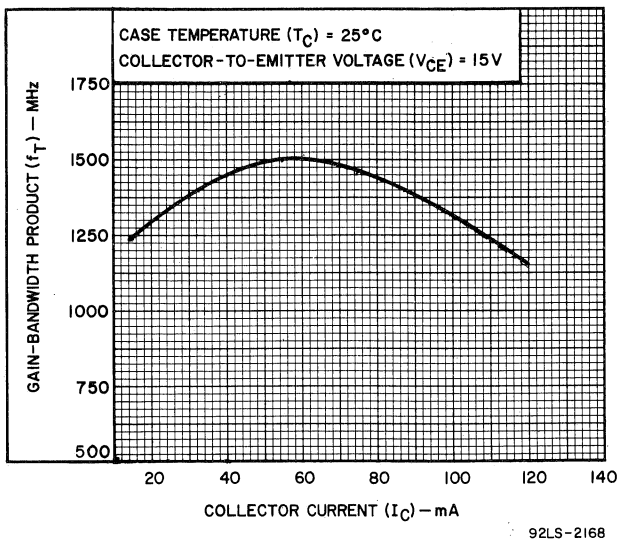

Fig. 1

RADIO CORPORATION OF AMERICA
ELECTRONIC COMPONENTS AND DEVICES, HARRISON, N.J.

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Printed in U.S.A.
6/67

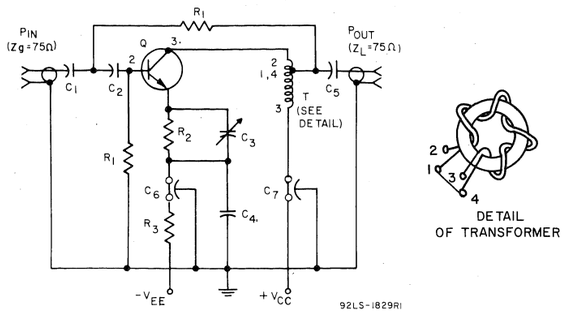
ELECTRICAL CHARACTERISTICS
Case Temperature = 25° C

Characteristic	Symbol	Test Conditions					Limits		Units
		DC Collector Volts		DC Current (mA)					
		V_{CB}	V_{CE}	I_E	I_B	I_C	Min.	Max.	
Collector-Cutoff Current	I_{CEO}		15		0			20	μA
Collector-to-Base Breakdown Voltage	BV_{CBO}			0		0.1	40		V
Collector-to-Emitter Sustaining Voltage: With external base-to-emitter resistance (R_{BE}) = 10 Ω	$V_{CER}(sus)$[a]					5	40		V
With base open	$V_{CEO}(sus)$				0	5	20		V
Emitter-to-Base Breakdown Voltage	BV_{EBO}			0.1		0	3		V
Collector-to-Emitter Saturation Voltage	$V_{CE}(sat)$				10	100		0.5	V
Collector-to-Base Capacitance (Measured at 1 MHz)	C_{ob}	15		0				3.5	pF
Forward-Current Transfer Radio	h_{FE}	15				50	70	210	
Small Signal Common Emitter Forward Current Transfer Ratio (Measured at 200 MHz)	h_{fe}	15				25	4.8		
		15				50	6		
		15				100	4.8		
Voltage Gain, Wideband, 50 to 216 MHz (See *Fig.2.*)	VG	15				50	11		dB
Cross Modulation @ 54 dBmV[b] Output (See *Fig.11.*)	CM	15				50	−57 (typ.)		dB
Power Gain, Narrowband, at 200 MHz P_{IN} = −10 dB (See *Fig.3.*)	PG	15				10	11		dB
Noise Figure, At 200 MHz, (See *Fig.3.*)	NF	15				10	3 (typ.)		dB

[a]Pulsed through an inductor (25 mH); duty factor = 50%.

[b]O dBmV = 1 millivolt

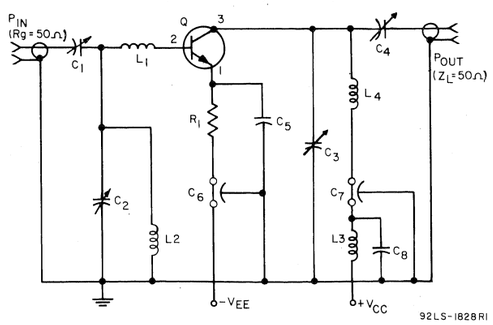
RF AMPLIFIER CIRCUIT FOR VOLTAGE GAIN TEST



C_1, C_2, C_5: 0.002 μF
C_3: 8 – 60 pF, ARCO 404, or equivalent
C_4: .03 μF
C_6, C_7: 1,500 pF
R_1: 390 Ω, 1/2 W
R_2: 6.8 Ω, 1/2 W
R_3: 330 Ω, 1 W
R_4: 200 Ω, 1/2 W
Q: 2N5109
T: 4 turns, Bifilar winding, 3/16" I.D., Core IG material – Q_1 No.30 wire, or equivalent

Fig. 2

RF AMPLIFIER CIRCUIT FOR POWER GAIN TEST (200-MHz Operation)



C_1, C_2, C_3: 1.0 – 30 pF
C_4: 1.0 – 20 pF
C_5: 10,000 pF
C_6, C_7: 1,000 pF
C_8: .01 μF
L_1: 4-1/2 turns, No.22 wire, 3/16" I.D.
L_4: 3-1/2 turns, No.22 wire, 3/16" I.D.
L_2, L_3: 0.82 μH RFC
R_1: 240 ohms, 2 watts
Q: 2N5109

Fig. 3

SUSTAINING VOLTAGE vs. BASE-TO-EMITTER RESISTANCE

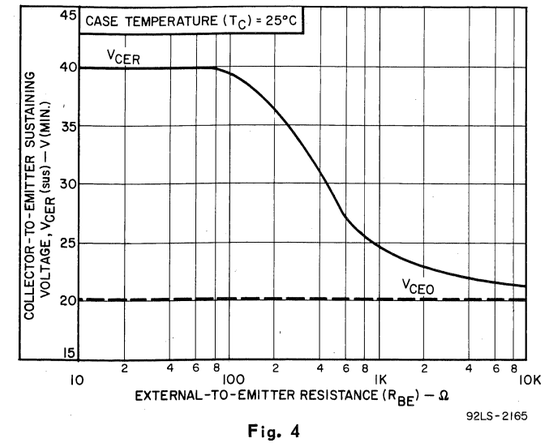


Fig. 4

TYPICAL SERIES INPUT RESISTANCE vs. FREQUENCY

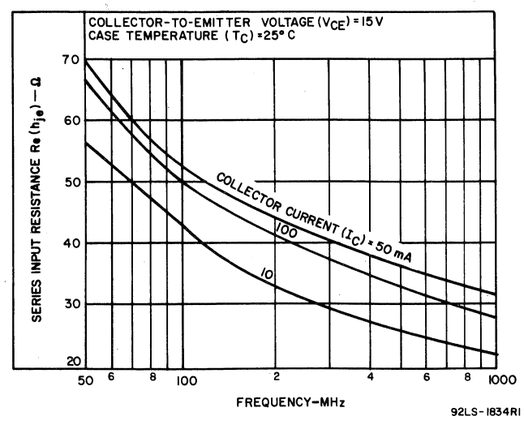


Fig. 5

TYPICAL POWER GAIN AND NOISE FIGURE vs. COLLECTOR CURRENT

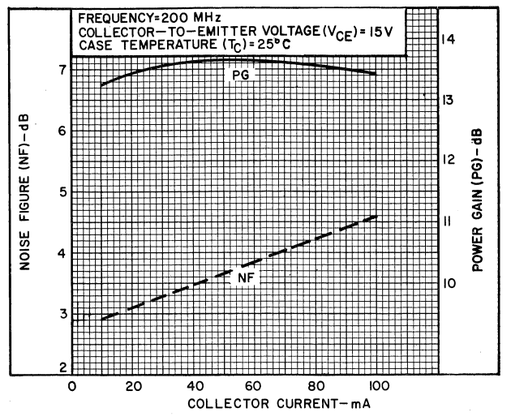


Fig. 6

TYPICAL PARALLEL OUTPUT CAPACITANCE vs. FREQUENCY

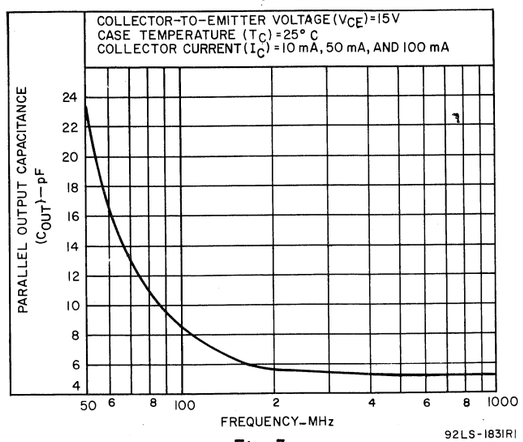


Fig. 7

TYPICAL PARALLEL OUTPUT RESISTANCE vs. FREQUENCY

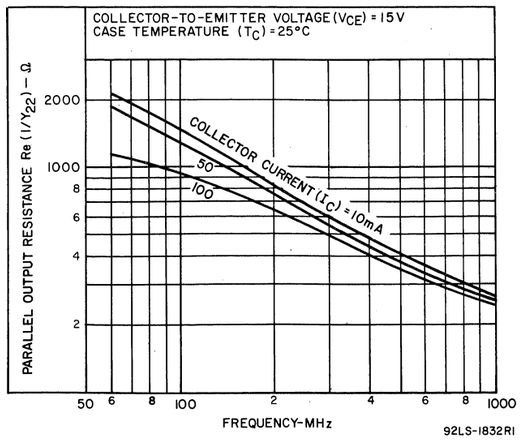


Fig. 8

TYPICAL SERIES INPUT REACTANCE vs. FREQUENCY

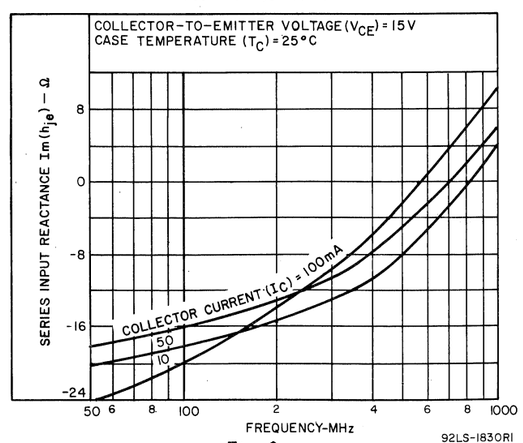


Fig. 9

DISSIPATION DERATING CURVE

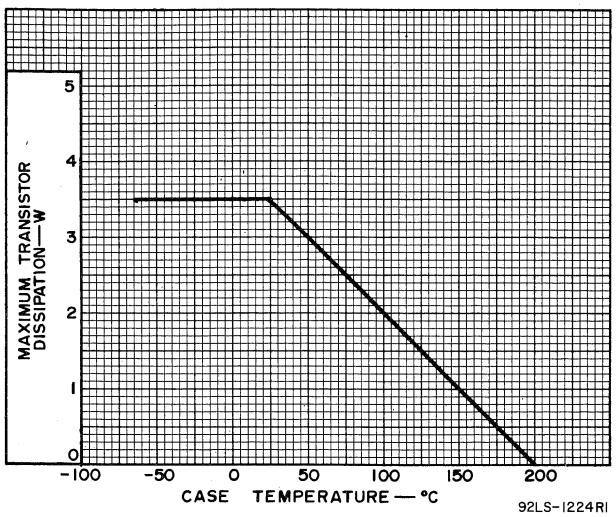
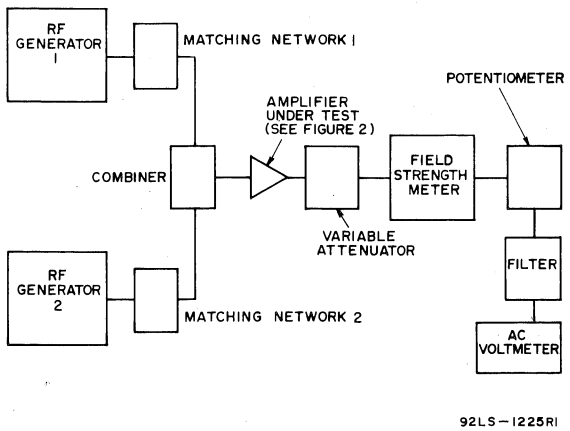


Fig. 10

BLOCK DIAGRAM FOR CROSS MODULATION TEST



Generator 1 & 2:	HP608D[a], or equivalent
Matching Network 1 & 2	50 to 75 ohms
Combiner:	20 dB isolation between generators
Variable Attenuator:	As required
Field Strength Meter, with Detector Output:	50–220 MHz
Filter:	1000 Hz
AC Voltmeter:	Ballantine 861[b], or equivalent

Fig. 11

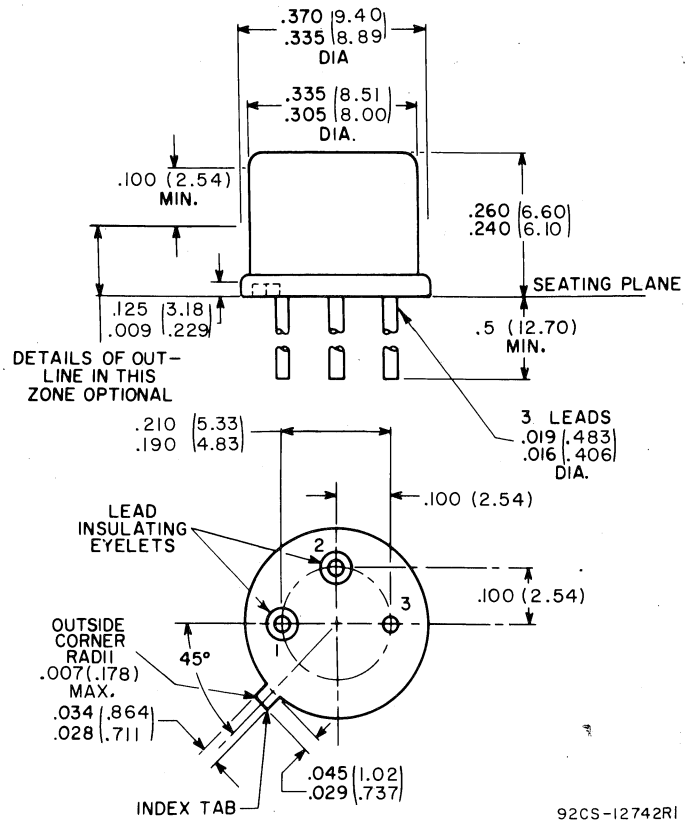
[a]Hewlett-Packard, 1501 Page Mill Road, Palo Alto, California 94304

[b]Ballantine Laboratories, Inc., 90 Fanny Road, Boonton, N.J.

OPERATING INSTRUCTIONS FOR CROSS MODULATION TEST

1. Set up equipment as shown in *Fig.11.*
2. Set generator 1 to 150 MHz modulated 30% by 1,000 hertz, and tune field strength meter to 150 MHz.
3. Adjust output level of generator 1 to give rated output from the amplifier under test.
4. Adjust potentiometer and AC voltmeter for a convenient level. This level then corresponds to 100% cross modulation.
5. Remove modulation. Readjust output level of generator 1 if necessary to obtain the AC voltmeter "100% level". Do not readjust generator 1 during the following steps.
6. Set generator 2 to 210 MHz modulated 30% by 1,000 hertz and tune field strength meter to 210 MHz.
7. Adjust output level of generator 2 to give rated output of the amplifier, i.e. The AC voltmeter indicates the "100% level".
8. Tune field strength meter to 150 MHz CW and read the AC voltmeter (a change of the AC voltmeter scale may be necessary).
9. Calculate percentage of cross modulation by comparing the reading of step 8 to the "100% level".

DIMENSIONAL OUTLINE FOR JEDEC TO-39



DIMENSIONS IN INCHES AND MILLIMETERS

Note: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

TERMINAL CONNECTIONS

Lead No.1 - Emitter

Lead No.2 - Base

Case, Lead No.3 - Collector